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1835

THE COTTON SPINNER'S MANUAL.

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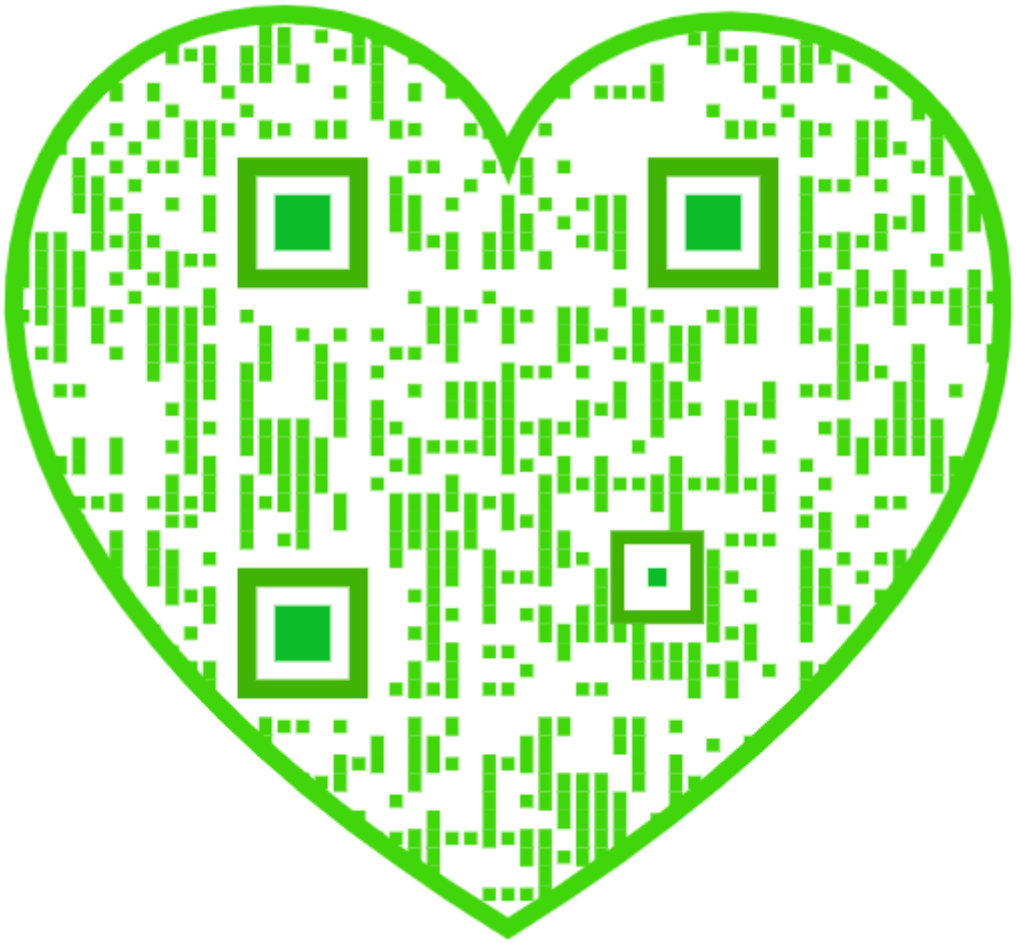

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THE

THEORY AND PRACTICE

OF

COTTON SPINNING;

Or the CARDING AND SPINNING MASTER'S ASSISTANT: showing the use of each Machine employed in the whole process—how to adjust and adapt them to suit the various kinds of Cotton, and the different qualities of Yarn.—And how to perform the various Calculations connected with the different departments of COTTON SPINNING.—Also, an Historical Sketch of the Rise and Progress of COTTON SPINNING, and a short Account of the cultivation of Cotton, Quantities Imported and Consumed, Different Growths, &c.

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THE

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OR

A COMPENDIUM

OF

THE PRINCIPLES

OF

COTTON SPINNING:

EXEMPLIFYING

The Method of Adjusting the Speeds, Calculating the Draughts, and performing the other Calculations required in a COTTON SPINNING FACTORY:

ALSO,

How to find the Aggregate Price of the various Mixtures of Cottons, and Copious Tables, by which the Wages of Operative Spinners are regulated.

GLASGOW:

PUBLISHED BY JOHN NIVEN, JUN., TRONGATE.

MDCCCXXXV.

110.

PREFACE.

THE great utility and advantages resulting to operatives or mechanics from practical works, is universally admitted by all who have paid any attention to the subject. They supply the means of attaining a correct knowledge of the fundamental principles of the particular arts upon which they treat, and enable the artizan to improve from the experience and observation of others. And the perfection to which the mechanical arts have attained in this country is, doubtless, in a great measure, owing to the number of such works that have issued from the press.

About two years ago, the author of this little Work published a treatise upon cotton spinning, entitled, "The Theory and Practice of Cotton Spinning, or the Carding and Spinning Master's Assistant;" which, from the variety of subjects it embraced, and the minuteness of the details entered into, unavoidably increased the work to an extent considerably above what was originally contemplated. Having learned that its size and price were considerable objections to it amongst operatives, and that it was supposed to be a work more adapted for proprie-

tors and managers, generally, than for those in any particular department of a Spinning Factory; the present work has been undertaken with a view to obviate these objections. Its *chief* object is utility, and no pains has been spared to render it as useful as possible to those engaged in the practical departments of the business. But from its limited extent it cannot be supposed to embrace the whole subjects connected with cotton spinning: in this respect, it can only be regarded as an introduction to the other work mentioned above; yet it is believed it will be found to comprehend much that is useful for carding and spinning masters as well as for operatives who may wish to acquire a knowledge of the calculations required in the different departments of the process. Those desirous of attaining a more extensive knowledge of the business, may consult "The Theory and Practice of Cotton Spinning, or the Carding and Spinning Master's Assistant," where they will find every thing connected with cotton spinning fully treated—also, an historical account of the rise and progress of cotton spinning—the cultivation of cottons—quantities imported and consumed—different growths, &c.

JAMES MONTGOMERY.

JANUARY, 1835.

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THE

COTTON SPINNER'S MANUAL.

CALCULATIONS OF SPEEDS, &c.

As it is of considerable importance in a Cotton Spinning Factory, that the speeds of the various machines be properly adjusted, it may be proper before proceeding, to exemplify the method of performing the other calculations, that the principles by which the speeds of the different movements are ascertained and traced out from the first moving power, be distinctly laid down and explained.

The speed of the main shaft in each department of the Factory, should be adjusted so as to allow the speed of the various machines to be regulated to the best advantage. For example, the speed of the main shafts in the picking and carding rooms, should run from 100 to 108 revolutions per minute; and that in the spinning department, from 90 to 96.

The speeds of the different machines are regulated as follows: Those of the scutching and spreading ma-

chines, by the revolutions of the scutchers per minute. The carding engine, by the revolutions of the main cylinder per minute. The drawing and tube frames, by the revolutions of the front rollers. The throstle and fly frames, by the revolutions of the spindles: and the can or roving frame, by the revolutions of the cans. The speeds of the stretching frame and the mule are regulated generally by the revolutions of the rim or fly per minute, and sometimes by the revolutions of the spindles.

To find the speed of the first shaft from the engine.

RULE. Multiply the number of strokes of the engine per minute by the number of teeth in the wheel attached to the crank, and divide the product by the teeth in the pinion on the end of the first shaft.

EXAMPLE.

Suppose the engine makes 24 strokes per minute, with a wheel of 90 teeth attached to the crank, and working into a pinion on the end of the first shaft containing 45 teeth.

Strokes of engine per minute, 24
Crank wheel, . . . 90

Pinion on first shaft, . 45)2160(48 speed of first shaft.
180

360

To find the speed of the second or upright shaft that conveys motion to the different departments.

RULE. Multiply the number of teeth in the driving wheel on the first shaft by its speed per minute, and divide the product by the teeth in the pinion on the bottom of the upright shaft. The result is the speed of the upright shaft per minute.

EXAMPLE.

Suppose the speed of the first shaft 48 revolutions per minute, with a wheel on the same, containing 54 teeth working into a pinion on the bottom of the upright shaft containing 36 teeth.

Speed of first shaft, . 48
Driving wheel on do. . 54

192
240

Pinion on bottom of upright, 36)2592(72 speed of upright shaft.
252

72
72

To find the speed per minute of the main shaft in the spinning room.

RULE. Multiply the speed per minute of the upright shaft by the number of teeth in the wheel on the top of

it, and divide the product by the teeth in the pinion on the end of the main or cross shaft.

EXAMPLE.

Suppose the speed of the upright shaft to be 72 revolutions per minute, with a wheel of 48 teeth, driving a pinion of 36 teeth on the end of the cross shaft that gives motion to all the spinning machines.

Speed of upright shaft, 72
Driving wheel on do. 48

576
288

Pinion on cross shaft 36)3456(96 speed of main shaft in spinning room.
324

216
216

To find the speed per minute of the main shaft in the carding room, supposing the cross shaft, which enters the carding room from the upright shaft, to move at the same rate as that which enters the spinning rooms, viz. 96 *revolutions per minute.*

RULE. Multiply the number of teeth in the driving wheel on the end of the cross shaft by its speed per minute, and divide the product by the teeth in the pinion on the main shaft.

EXAMPLE.

Suppose the speed of the cross shaft 96 revolutions per minute, with a driving wheel on the same, containing 36 teeth working into a pinion on the main shaft of 32 teeth.

Speed of cross shaft, . 96
Driving wheel on do. . 36

576
288

Pinion on main shaft, 32)3456(108 speed of main shafts in the carding and picking rooms.
32

256
256

To find the speed of any given shaft.

RULE. Begin at the first driving wheel attached to the engine crank, and trace out all the driving and driven wheels separately, from the first driver to the last driven on the first end of the given shaft. Multiply the number of teeth in all the driving wheels together, and the product by the revolutions of the crank per minute: then multiply all the driven wheels together, and divide the product of the former by the product of the latter; the result is the speed of the given shaft.

EXAMPLE.

Required the speed per minute of the cross shafts that enter the spinning or carding rooms.

DRIVERS.		DRIVEN.	
1st driving wheel,	90 teeth.	1st driven pinion,	45
2d do.	54	2d do.	36
	4860		270
3d do.	48		135
	38880		1620
	1944	3d do.	36
	233280		9720
Revolutions of crank,	24		486
	933120		58320
	46656		

58320)5598720(96 speed per minute of cross shafts
524880 in spinning and carding rooms.

349920
349920

To find the speed per minute of the main cylinder in the carding engine.

RULE. Multiply the revolutions per minute of the main shaft in the carding room, by the diameter of the drums, which give motion to the carding engines by means of a belt or strap, and divide the product by the diameter of the fast and loose pullies on the axle of the main cylinder.

EXAMPLE.

Suppose the speed of the main shaft 108 revolutions per minute, the diameter of the drum on the main shaft

18 inches, and the diameter of the fast and loose pullies on the axle of cylinder 17 inches.

Speed of main shaft, . . 108
Diameter of drum on do. . 18 inches

864
108

Diameter of belt pullies, 17)1944(114.35 revolutions of main cylinder per minute.
17

24
17

74
68

6

To find the revolutions per minute of the front rollers in the drawing frame.

RULE. Trace out all the driving and driven pullies or drums from the main shaft to the drawing frame shaft which gives motion to its different parts, commonly called the cylinder shaft: multiply the diameters of all the driving pullies or drums together, and the product by the speed per minute of the main shaft: then multiply the diameters of all the driven pullies or drums together, and divide the product of the former by the product of the latter; the result will be the speed of the frame shaft per minute.

EXAMPLE I.

Suppose the diameter of the driving drum on main shaft to be 18 inches, and driving a changing or speed pulley of 16 inches, on the same shaft with which, there is another driving drum of 18 inches, driving a pulley on the end of the cylinder, or frame shaft, of 16 inches diameter.

Speed of main shaft, . 108 | Diam. of 1st driven pulley 16
Diameter of drum on shaft 18 in. | Do. of 2d do. 16

864 | 96
108 | 16
1944 | 256

Diam. of 2d driving drum 18

15552
1944

256)34992(136.68 rev. per minute of cylinder shaft in the drawing frame.
256

939
768

1712
1536

1760
1536

2240
2048

192

Motion is conveyed from the cylinder shaft to the front rollers, by means of a belt or strap passing from a small drum on the shaft, to the fast and loose pullies attached to the drawing head; therefore find the revolutions of the rollers by multiplying the diameter of the small drum on the cylinder shaft by its revolutions per minute, and the product by the number of teeth in the wheel fixed to the fast and loose pullies on the drawing head: and again, multiply the driven pinion on the front roller by the diameter of the fast and loose belt pullies. Divide the product of the former by the product of the latter; the result is the revolutions of the front rollers per minute.

EXAMPLE II.

Speed of cylinder shaft, 136.68 | Diam. of fast & loose pul. 6
Diam. of small drum on do. 5 in. | Pinion on front roller 38

683.40 228

Teeth in wh. fixed to f. & l. pul. 76

410040
478380

228)51938.40(227.8 revolutions of the front rollers per minute.
456

633
456

1778
1596

1824
1824

The method of finding the revolutions of the front rollers in the tube and fly frames is exactly the same as that exemplified in the preceding Examples. And it may be laid down as a general rule, that all these calculations proceed upon one uniform principle, viz. to separate all the driving wheels or pullies from the driven: and if wheels, multiply the number of teeth; but if pullies or drums, multiply the diameters of all the drivers together, and the product by the speed given: then multiply all the driven together, and divide the greater by the less; the result will give the speed sought. The above principle is fully illustrated and explained in the "Theory and Practice of Cotton Spinning."

To find the revolutions per minute of the rim or fly in the mule jenny.

RULE. Multiply the speed per minute of the main shaft by the diameter of the driving drum upon the same, and the product by the second drum that gives motion to the mule; and multiply the diameter of the changing speed pulley by the diameter of the fast and loose belt pullies on the axle of the fly or rim. Divide the product of the former by the product of the latter; the result is the speed of the fly per minute.

EXAMPLE.

Suppose the revolutions per minute of the main shaft 96, (*see page* 12) and the diameter of the driving drum

on main shaft 20 inches, also the second driving drum 20 inches, with changing speed pullies, and pullies on the axle of the fly 18 inches each.

Speed per min. of main sh. 96
1st driving drum on do. 20 in.
1920
2d driving drum, . . 20 inches
324)38400(118.51 revolutions of the fly or rim per min.
324
600
324
2760
2592
1680
1620
600
324
276

Diam. of chang. speed pul. 18
Do. on fast & loose pullies on fly axle 18
144
18
324

The above example gives the revolutions of the fly on what is termed the single speed, but when the mule is mounted with what is denominated the double speed, the revolutions of the fast and loose pullies must be multiplied by the number of teeth in the driving wheel attached to the same, and divided by the teeth in the driven wheel on the axle of fly. *(See the Theory and Practice of Cotton Spinning, pp. 29 & 30, 2d edition.*

All mule jennies that are made in this country, are constructed upon the same principle, with a large fly or rim, generally from 36 to 40 inches in diameter; hence the speed of the rim when spinning average numbers, may range from 108 to 120 revolutions per minute. Many of those mules made in England, however, have a small rim, and consequently require to be driven at a much higher speed, extending, in many cases, to nearly 300 revolutions per minute. But whatever be the speed of the rim, the spindles cannot, with safety, exceed 4800, or thereby.

The speed per minute of the fly or rim being given— To find the revolutions of the front rollers.

RULE. Multiply the speed of the fly by the number of teeth in the bevel wheel on its axle, and the product by the teeth in the wheel on the bottom of the bevel shaft* for a dividend, and multiply the number of teeth in the wheel on the top of the bevel shaft and the wheel on the coupling shaft together for a divisor. Divide the former by the latter, and the result is the revolutions of the front rollers per minute.

---

* The bevel shaft is sometimes called the long driver in distinction from the short driver, another bevel shaft, which drives a scrall or scroll for taking out the carriage.

EXAMPLE.

Suppose the wheel on the axle of the fly to contain 42 teeth, the wheel on the top of the bevel shaft 50 teeth, and that on the under end of the shaft 34 teeth, with a wheel on the coupling shaft containing 50 teeth.

Speed of fly per minute, 118.51 | Wheel on top of bev. sh. 50 teeth
Teeth in bev. wh. on axle of fly 42 | Do. on coupling shaft 50 do.

23702 2500
47404

4977.42
Do. on under end of shaft, 34

1990968
1493226

2500)169232.28(67.69 revolutions of front rollers per minute.
15000

19232
17500

17322
15000

23228
22500

728

To find the revolutions of the fly for one of the front rollers.

RULE. Multiply the number of teeth in the wheel on axle of fly, by the teeth in the wheel on under end of bevel shaft; then multiply the teeth in the wheel on the top of bevel shaft, by the wheel on the coupling shaft. Divide the product of the latter by the product of the former; the result is the revolutions of the fly for one of the rollers.

EXAMPLE.

Wheel on top of bev. sh. 50 | Wheel on axle of the fly, 42 teeth
Do. on coupling shaft, 50 | Do. on under end of bev. sh. 34 do.

1428)2500(1.75 rev. of the fly for one of the front rollers
1428
10720
9996
7240
7140

168
126
1428

If the length of the stretch be 56 inches, the gaining of the carriage 6 inches, and the circumference of the front rollers 3.14: Required the revolutions of the fly whilst the carriage is receding from the rollers?

RULE. Subtract the gaining of the carriage from the full length of the stretch, and divide the remainder by

the circumference of the rollers; the result will be the revolutions of the rollers in one stretch, which multiplied by the revolutions of the fly for one of the rollers, gives the revolutions of the fly during the receding of the carriage.

EXAMPLE.

Full length of the stretch, . . 56 inches.
Subtract the gaining, ... 6

Divide by circumference of rollers 3.14)50.00(15.92 revolutions of the front rollers in one stretch.

	314
	1860
	1570
	2900
	2826
	740
	628
	112

Revolutions of the rollers in one stretch, 15.92
Do. of fly for one of rollers, . 1.75

	7960
	11144
	1592
Revolutions of the fly . .	27.8600 during the receding of the carriage.

It is difficult to lay down any rule by which the revolutions of the spindles for one of the fly can be accurately ascertained, and therefore in practice it is seldom found by calculation. The method generally adopted, is to put a mark on the spindles, and move the fly once round with the hand, at the same time counting each revolution of the spindles.

The length of the stretch, the revolutions of the fly in one stretch, together with the revolutions of the spindle for one of the fly being given—To find the twist per inch on the yarn.

RULE. Multiply the revolutions of the fly in one stretch, by the revolutions of the spindle for one of the fly, and divide the product by the full length of the stretch.

EXAMPLE.

Suppose the length of the stretch to be 56 inches, revolutions of fly in ditto 39, and revolutions of spindles for one of the fly 42.

Revolutions of fly in one stretch, 39
Do. of spindle for one of fly, 42

78
156

Length of the stretch, 56)1638(29.25 twists per inch on the yarn.
112

518
504

140
112

280
280

The revolutions per minute and circumference of the front rollers being given—To find the length of yarn delivered per minute.

RULE. Multiply the circumference of the rollers by their revolutions per minute.

EXAMPLE.

Revolutions of rollers 67.69, circumference of do. 3.14 inches. $67.69 \times 3.14 = 212.54$ inches of yarn delivered per minute by the front rollers of the mule.

The method by which the speed of the drawing frames is ascertained was exemplified at page 17, where it was also stated, that the speeds of the fly or tube frames

were found by exactly the same process. Therefore the speed of the fast and loose pullies in the fly frame being given—

To find the revolutions per minute of the front rollers.

RULE. Multiply the speed per minute of the frame shaft, on which the fast and loose pullies are fixed, by the number of teeth in the small wheel that gives motion to the rollers, and divide the product by the teeth in the twist wheel fixed on the end of the front rollers.

EXAMPLE.

Suppose the frame shaft upon which the pullies are fixed to revolve 230 times per minute; upon this shaft there is a pinion containing 28 teeth, giving motion to the rollers: on the end of the front roller is a twist wheel of 60 teeth, receiving motion by means of intermediate wheels.

Speed of shaft per minute, . . 230
Teeth in the driving wheel on the shaft, 28

1840
46

Teeth on twist wheel on front roller 6|0)644|0

107.33 revolutions of the front rollers in the fly frame per minute.

The revolutions of the rollers per minute, multiplied by their circumference, give the length produced per minute.

EXAMPLE.

Revolutions of rollers per minute 107.33
Circumference of do. suppose 3.93 inches.

32199
96597
32199

421.8069 inches of roving produced from the fly frame per minute.

Motion is communicated to the spindles in the fly frame by means of a small bevel shaft, extending from the frame shaft to another shaft immediately under the spindle steps, called the under shaft, upon which there are a number of small wheels working into pinions fixed on the feet of the spindles.

To find the revolutions per minute of the spindles in the fly frame.

RULE. Multiply the revolutions per minute of the frame shaft, by the teeth in the wheel that drives the bevel shaft, and the product by the wheel on the under end of bevel shaft and by the pinion fixed on the under shaft, which drives the spindles; then multiply the number of teeth in the wheels on the top of bevel shaft—the driven wheel on under shaft, and the pinion fixed on the foot of the spindle together. Divide the product of the former by the product of the latter; the result is the revolutions of the spindle per minute.

EXAMPLE.

DRIVERS.	DRIVEN.
Speed of frame shaft, ... 230 rev.	Wheel on top of bevel shaft, 48 teeth
Wheel on do. ..... 70 teeth	Driven wheel on under shaft, 57 do.
Do. on under end of bevel do. 57 do.	Pinion fixed on spindle foot, 30 do.
Driving pinion on under do. 49 do.	

Speed of shaft, . . 230 | Wheel on top of bevel shaft 48
Wheel on do. . . 70 | Driven wheel on under shaft 57

16100 — 336
Do. under end of bevel do. 57 — 240
112700 — 2736
80500 — Pinion on spindle, 30
917700 — 82080
Pinion on under shaft, 49
8259300
36708

82080)44967300(547.84 revolutions per minute of the spindles.
410400
392730
328320
644100
574560
695400
656640
387600
328320
59280

To find the twists per inch in the roving produced from the fly frames.

RULE. Divide the revolutions of the spindle per minute, by the length delivered.

EXAMPLE.

Length delivered, 421.80)547.84(1.29 twists per inch on the roving.

421.80

126040
84360

416800
379620

37180

The process by which the revolutions of the front rollers in the tube frame are ascertained, is the same as that given in page 26, which it is unnecessary to repeat: it may be stated, however, that the speed of the front rollers, in tube frames, in general, range from 360 to 400 revolutions per minute; and the average produce of the fly and tube frames in 12 working hours, is generally as follows:

Each tube of the tube frame produces in 12 working hours,	Each spindle of the fly frame produces in 12 working hours,
From 24 to 26 hks. of 2 hks. rov.	From 4½ to 6 hks. of 2 hks. rov.
24½ to 27 do. 2½ do.	5 to 6½ do. 2½ do.
25 to 28 do. 3 do.	5½ to 6½ do. 3 do.
25½ to 28½ do. 3½ do.	6 to 7 do. 3½ do.
26 to 29 do. 4 do.	6½ to 7½ do. 4 do.

Those desirous of seeing the foregoing calculations of speeds carried out to their utmost extent, may consult "The Theory and Practice of Cotton Spinning," where they are all given at full length; as from the limited nature of this work, and the want of drawings, it is difficult to exemplify them in a sufficiently intelligible manner.

The following summary of speeds, however, is here given for the benefit of those who may not have the above work at hand.

SUMMARY OF SPEEDS.

The speed of the willow may be regulated at from 315 to 320 revolutions per minute, supposing its diameter $2\frac{1}{2}$ feet.

The scutchers in the scutching machine may be regulated at from 1300 to 1600 revolutions per minute, and 100 revolutions of the scutcher for one of the feeding rollers. Double scutching machines are now generally made with the first and second scutchers to revolve at equal speeds. The scutcher in the spreading machine may be regulated at 1000 revolutions per minute.

The rollers in the lapping machine, if their diameter be four inches, may be regulated at from 30 to 40 revolutions per minute.

The main cylinder in carding engines, when regulated at 112 revolutions per minute, is considered a good medium speed; in many cases, however, it extends to 120 and upwards; but when it exceeds 120, it is likely to prove more injurious than otherwise.

The front rollers in the drawing frame, supposing their diameter $1\frac{1}{8}$ inches, may be regulated at from 220 to to 230 revolutions per minute. And the front rollers of the fly frame, supposing their diameter one inch, at from 105 to 115 revolutions per minute. Those in the tube frame, from 360 to 400 revolutions per minute.

The front rollers in the common throstle frame, if their diameter be one inch, may be regulated at 54 or 56 revolutions per minute when spinning No. 20. Those in the Danforth and Glasgow Patent Throstles, at about 90 revolutions for the same No.

No general rule can be laid down for the speeds of the mule and stretching frames, as these are regulated according to circumstances. And although the above be a summary of what is considered good medium speeds, yet the speeds of all machinery in cotton mills are often varied according to particular circumstances. This, however, should be done as seldom as possible, as it is always found that every machine works to the best advantage when driven at a medium speed. And here it

may be observed, that there are three things of the utmost importance to be attended to in the plan and arrangement of all Cotton Spinning Factories. 1st, An adequate supply of propelling power, so that a regular and uniform speed may always be kept up. 2d, A full command of preparation machinery. And 3d, A sufficiency of room, so as to admit of the most advantageous arrangement of all the machinery. Any Factory where these three things have been attended to, must possess a decided advantage over all others not placed in so favourable circumstances.

CALCULATIONS OF DRAUGHTS, &c.

To find the draught of a carding engine.

RULE. Commence at the wheel upon the end of the feeding rollers, call it the first leader, and the small stud pinion working in the same, the first follower; so trace out all the leaders and followers from the feeding rollers to the delivering shaft, the wheel on the end of which will be the last follower. Multiply the number of teeth in all the leaders together, and their product by the diameter of the delivering shaft: then multiply the teeth in all the followers together, and the product by the diameter of the feeding rollers. Divide the product of the former by the product of the latter; the result is the draught of the carding engine.

Note. All intermediate wheels or drums are omitted in the calculation of draughts, or the speeds of shafts and machines. And when wheels containing the same number of teeth, or drums and pullies of the same diameter, occur on both sides, that is, both as leaders and followers, or drivers and driven, they are always left out in the operation.

EXAMPLE.

DRIVERS.		DRIVEN.	
Wheel on feeding rollers,	144 teeth	1st stud pin. driving feed. rol.	14 teeth
First stud wheel, . .	*144 do.	2d stud wheel, . . .	*144 do.
2d stud pin. driving doffer,	46 do.	Wheel on delivering shaft,	22 do.
Diameter of delivering shaft.	2¼ in.	Diameter of feeding rollers,	1 inch

144
46

864
576

6624
2¼

13248
1656

14
22

28
28

308

308)14904(48.38 draught of carding engine.
1232

2584
2464

1200
924

2760
2464

296

* These are omitted as occurring on both sides.

To find the revolutions of the doffing cylinder on carding engines for one of the main cylinder.

RULE. Multiply the number of teeth in the pinion on the axle of the main cylinder, by the teeth in the stud pinion driving the doffer wheel: then multiply the teeth in the doffer wheel, by the teeth in the stud wheel working into the pinion on the main axle. Divide the product of the latter by the product of the former; the result is the revolutions of the main cylinder for one of the doffer.

EXAMPLE.

	Teeth.		Teeth.
Wheel on end of doffer shaft,	144	Pinion on main cylinder,	20
Stud wheel, . .	144	Stud pin. driving doffer,	46
	576		920
	576		
	144		
	920)20736(22.53	revolutions of main cylinder for one of doffing cylinder.	
	1840		
	2336		
	1840		
	4960		
	4600		
	3600		
	2760		
	840		

To find the revolutions of the main cylinder for one of the feeding rollers.

RULE. Multiply the number of teeth in the wheel fixed on the end of the feeding roller, by the teeth in the first stud wheel; and the teeth in the feeding pinion, by the teeth in the pinion on main axle. Divide the product of the former by the product of the latter; the result is the revolutions of main cylinder for one of the feeding rollers.

EXAMPLE.

Wheel on end of feed. rollers, 144 teeth | Feeding pinion, 14 teeth
First stud wheel, . 144 do. | Pin. on main axle, 20 do.

576 — 280

576
144

280)20736(74 revolutions of main cylinder for one of feeding rollers.
1960

1136
1120

16

In general the revolutions of the main cylinder for one of the doffer, range from 18 to 24: and from 64 to 78, for one of the feeding rollers.

Experienced carding masters, in general, prefer feeding slow, and delivering quick, unless for very short stapled cotton, such as surats, waste, &c. which are

put through the carding process with as little operation as possible, often with a feeding pinion of 16 teeth, and 25 or 26 on the axle of cylinder.

The revolutions of the main cylinder being given— To find the length delivered by the carding engine per minute.

RULE. Find the revolutions per minute of the delivering shaft, and multiply the same by its circumference.

EXAMPLE.

DRIVERS.	DRIVEN.
Revolutions of main cylin. 114.35	2d stud wheel 144 teeth.
Pinion on main axle, . . 20 teeth.	Pinion on delivering shaft 22 do.
2287.00	
Stud pinion driving doffer, 46 teeth.	288
	288
1372200	
914800	3168

3168)105202.00(33.20 revolutions of delivering shaft per minute.

9504

10162

9504

6580

6336

2440

Multiply the foregoing result by the diameter of the delivering shaft, viz. $2\frac{1}{4}$ inches.

EXAMPLE.

$33.17 \times 2\frac{1}{4} = 74.63$ length delivered by carding engine $\mathfrak{P}$ minute.

The above calculations are adapted to most of the carding engines made in Scotland, as they are generally all constructed upon the same plan in the side gearing. In England they are rather different, yet the principle is the same, and if once properly understood, may easily be applied to any form of the machinery. Some carding engines are made with a side shaft extending from the doffing cylinder to the feeding rollers; the draught of which is found by the following process.

RULE. Multiply the number of teeth in the wheel on the doffer shaft, by the teeth in the wheel on the under end of side shaft, and the product by the diameter of the feeding rollers: then multiply the teeth in the wheel on the end of the feeding rollers, by the wheel on the top of the side shaft, and the product by the diameter of the doffing cylinder. Divide the product of the latter by the product of the former; the result is the draught required.

EXAMPLE.

Wheel on end of feed. roll. 150 teeth
Do. on top of side shaft 35 do.

750
45

5250

Diameter of doffer . 18 inches.

42000
5250

Wh. on end of dof. 30 teeth.
Pin. on under end of side shaft 24 do.

720

Diam. of feed. roll. 2 in.

1440

1440)94500(65.62 draught required.
8640

8100
7200

9000
8640

3600
2880

720

Mode of adjusting a carding engine.

Set the feeding rollers and the cylinders to a perfect level, then place the doffing cylinder and the feeding

rollers as close to the main cylinder as possible without touching. Keep the foreside of the tops (that is, the side next to the feeding rollers) about $\frac{3}{16}$ of an inch off the sheets on the main cylinder, but let the opposite side of the tops be set as close as will just allow the one to pass the other freely without touching. If the carding engine be set or adjusted in this manner, kept sharp, and well cleaned, it may fairly be expected, with good management, to give complete satisfaction.

TABLE *of Sheets and Filletings for Carding Engines.*

To card for all Nos.	Cylinder Sheets.	Crowns.	Tops, 1st 2d & 3d.	Crowns.	Tops, 4th 5th 6th 7th & 8th.	Crowns.	Tops, 9th 10th & 11th.	Crowns.	Breadth of Top Sheets.	Filletings.	
Between	80	8	20	7	26	7	28	8	$1\frac{1}{2}$	90	Breakers.
No. 10 & No. 36	80	9	24	8	28	8	30	8	$1\frac{1}{2}$	90	Finishers.
Between	80	9	26	7	30	8	35	9	$1\frac{1}{2}$	90	Breakers.
No. 36 & No. 100	90	10	30	8	35	9	40	10	$1\frac{1}{2}$	100	Finishers.
Between	90	10	30	8	38	9	40	10	$1\frac{1}{2}$	100	Breakers.
No. 100 & No. 200	100	12	35	9	40	10	45	12	$1\frac{1}{2}$	110	Finishers.

To find the draught of a drawing frame.

RULE. Begin at the back roller on the back beam, (that is, supposing the frame to have 2 beams,) on which is a wheel of 45 teeth, call this the first leader, and the pinion on the front roller the first follower; so trace out all the leaders and followers separately, from the small wheel on the back roller of the beam, to the wheel on the end of the delivering shaft, which is the last follower. Multiply the number of teeth in all the leaders together, and the product by the diameter of the delivering shaft; then multiply the number of teeth in all the followers together, and the product by the diameter of the back or feeding roller. Divide the product of the former by the product of the latter, and the result is the draught of the drawing frame.

LEADERS.	FOLLOWERS.
Wh. on back rol. of back beam 45 teeth	Pinion on fr. roll. of back beam 17 teeth
Wh. on front roll. of back beam driving back rol. of fr. beam 45 do.	Wheel on back roll. of fr. beam 42*do.
Wh. on back rol. of fr. beam 42*do.	Pinion on fr. roll. of fr. beam 17 do.
Wh. on front rol. of front beam driving delivering shaft . 38 do.	Wheel on end of deliver. shaft 76 do.
Diameter of delivering shaft 2⅛in.	Diameter of back roller . . 1 inch

* This wheel is both a leader and follower, therefore omitted in the operation.

45	17
45	17
225	119
180	17
2025	289
38	76
16200	1734
6075	2023
76950	21964
$2\frac{1}{2}$	
153900	
38475	

21964)192375(8.75 draught of the drawing frame.
175712

166630
153748

128820
109820

19000

To find the length delivered by the drawing frame per minute.

RULE. Multiply the speed of the frame shaft by the the diameter of the small drums upon the same, and divide the product by the diameter of the fast and loose belt pullies, on the side of the drawing head; the result

is the revolutions of the delivering shaft per minute; which multiplied by the circumference of the delivering shaft gives the length produced per minute, provided the wheel attached to the fast and loose belt pullies and that of the delivering shaft contains the same number of teeth each.

EXAMPLE.

Speed of frame shaft, . . 136.68
Diameter of small drum on do. 5 inches

Do. of fast and loose pullies 6|683.40

113.90 revolutions of delivering shaft per minute.

Circumference of delivering shaft, 7.85 inch.

56950
91120
79730

8941150 inches delivered per minute, by one head of the drawing frame.

To find the draught of the tube frame.

RULE. Begin with the pinion on the front roller of the front beam containing 20 teeth, call it the first driver and trace out the driving and driven wheels and pinions from it to the wheel on the back roller, which will be the last driven. Multiply the number of teeth in the driving pinions together, and their product by the diameter of the back roller; then multiply the number of teeth in all the driven wheels together, and the product by the diam-

eter of the front roller. Divide the product of the latter by the product of the former; the result is the draught required.

EXAMPLE.

DRIVERS.	TEETH	DRIVEN.	TEETH
Pinion on front roller of front beam,	20	Crown wh. between fr. & back beam,	62
Grist pinion on crown wheel, . .	18	Wheel on front roller of back beam,	30
Pinion on front roller of back beam,	20	Stud wheel on back beam, . . .	64
Stud pinion on back beam, . . .	35	Wheel on back roller of back beam,	50

18 × 20 = 360 × 20 = 7200 × 35 = 36000 + 21600 = 252000

62 × 30 = 1860 × 64 = 7440 + 1116 = 8556 × 50 = 427800

Dia. of back roller $\frac{8}{8}$ = 8

252000 × 8 = 2016000

Dia. of front roller $\frac{8}{8}$ = 9

427800 × 9 = 3850200

2016000)53568000(26.57 the draught required.

4032

13248

12096

11520

10080

14400

14112

288

To find the draught of the mule jenny.

RULE. Multiply the number of teeth in the pinion on the front roller, and the grist (or changing) pinion together, and the product by the diameter of the back roller; then multiply the teeth in the crown wheel (or top carrier) and back roller wheel together, and the product by the diameter of the front roller. Divide the product of the latter by the product of the former; the result is the draught required.

EXAMPLE.

Crown wheel, . .	72 teeth	Pinion on front roller	18 teeth
Back roller do. . .	56 do.	Grist or change pinion	28 do.
	432		144
	360		36
	4032		504
Dia. of front roller $\frac{8}{8} = 8$		Dia. of back roller $\frac{7}{8} = 7$	
3528)32256(9.14		draught of mule jenny.	3528
	31752		
	5040		
	3528		
	15120		
	14112		
	1008		

Note. The wheels and pinions given in the preceding calculation are only adapted to those mules made by Mr. Dunn of Glasgow. Scarcely any two machine makers put exactly the same pinions on their mules. Those made by Girdwood & Co. have 14 teeth in the pinion on the front roller, with 40 teeth in the back roller wheel, and 63 in the crown wheel. And those made by Mr. Holdsworth have 20 teeth in the front roller pinion, 53 in the back roller wheel, and 120 in the crown wheel. Consequently, it is deemed unnecessary to give tables of the draughts produced by the different grist pinions, unless these tables were adapted to all the various mules now in operation, which would increase this work to an improper size. The principle by which the draught of the mule is calculated having been exemplified, tables can easily be made out to suit the particular class of wheels and pinions upon any mules now in use.

The method of calculating the draught of the stretching frame is exactly the same as the mule, which need not be again exemplified.

To find the proper diameter of a mendoza pulley that will produce any given length of gaining.

RULE. Multiply the number of teeth in the mendoza wheel by the diameter of the front roller, and

divide the product by the number of teeth in the pinion on the coupling shaft, by which the mendoza wheel is driven; from the result thus obtained, subtract the diameter of the mendoza band, and the remainder will give the diameter of a pulley that will make the carriage recede from the rollers exactly as the yarn is given out without either gaining or losing.

Suppose the mendoza wheel contains 112 teeth, and the pinion on the coupling shaft that drives it 18 teeth, diameter of front roller 1 inch, and mendoza band $\frac{5}{8}$: Required the diameter of a pulley that will take out the carriage as the yarn is given out?

EXAMPLE.

$\frac{112 \times 1}{18} = 6\frac{4}{9}$, from which subtract the diameter of the mendoza band thus $6\frac{4}{9} - \frac{5}{8} = 5\frac{5}{8}$ diameter of pulley required.

Required the diameter of a pulley that will give 6 *inches of gaining on a stretch of* 56 *inches?*

RULE. Subtract the gaining required from the full length of the stretch; then, as the remainder is to the full length of the stretch, so is the diameter of the pulley found, as above, to the diameter of a pulley that will give the gaining required.

EXAMPLE.

Length of stretch, 56 inches.
Gaining required, 6 do.

50 : 56 : : $5\frac{5}{8}$
$5\frac{5}{8}$

280
35

50)315(6.3 diameter of pulley required to
300 give 6 inches of gaining on a
150 stretch of 56 inches.
150

Note. The gaining of the carriage for spinning different numbers of yarn may be arranged as follows:

For spinning from No. 25 to 32, the gaining of the carriage may range from 1 to $2\frac{1}{2}$ inches: between No. 32 and 46, from $2\frac{1}{2}$ to 4 inches: between No. 46 and 54, from 4 to 5 inches: between No. 54 and 64, from 5 to 6 inches: between No. 64 and 70, from 6 to 7 inches, &c. The second stretch might commence at No. 70, or perhaps No. 64; and from that to No. 84, it may range from 1 to 2 inches. Above these numbers it will increase according to the size* of the yarn. From No. 120 to 200, the second stretch will range from $4\frac{1}{2}$ to 7 inches.

* Size of yarn signifies its grist, which is distinguished by the number of hanks in one pound. In England it is denominated the counts of the yarn.

No rule can be laid down for ascertaining the proper quantity of twist to put on the yarn, on account of the great variety in the qualities of the cotton, and the different purposes to which the yarn is applied. The following Table has been taken from practice, and, as a general rule, will perhaps be found as good as any that could be made out.

TABLE *of Twists, to suit different Nos. of warp and weft yarns.*

TWISTS, OR WARP YARNS.					
NOS.		TWISTS.	NOS.		TWISTS.
40	requires	22½ ℔ inch	120	requires	42½ ℔ inch
50	—	25 ——	130	—	45 ——
60	—	27½ ——	140	—	47½ ——
70	—	30 ——	150	—	50 ——
80	—	32½ ——	160	—	52½ ——
90	—	35 ——	170	—	55 ——
100	—	37½ ——	180	—	57½ ——
110	—	40 ——	190	—	60 ——
WEFTS.					
NOS.		TWISTS.	NOS.		TWISTS.
40	requires	20 ℔ inch	120	requires	40 ℔ inch
50	—	22½ ——	130	—	42½ ——
60	—	25 ——	140	—	45 ——
70	—	27½ ——	150	—	47½ ——
80	—	30 ——	160	—	50 ——
90	—	32½ ——	170	—	52½ ——
100	—	35 ——	180	—	55 ——
110	—	37½ ——	190	—	57½ ——

MISCELLANEOUS CALCULATIONS.

To find the hank roving in stretching frames.

RULE. Multiply the number of teeth in the counter pinion by the teeth in the bell wheel, and the product by the circumference of the front roller, and multiply the last product by the number of spindles in the frame: then multiply the circumference of the reel by the threads in a lea, and the leas in a hank. Divide the product of the former by the product of the latter, and multiply the last result by the ounces in a pound, and divide by the weight of a set of rovings.

EXAMPLE.

Suppose the circumference of the front roller to be 3.14 inches, with a screw or worm on the coupling shaft, driving a counter pinion of 24 teeth, connected with which is another screw, driving a bell wheel containing 120 teeth. The spindles in the frame 120, and weight of a set of rovings 96 ounces.

Counter pinion, 24
Bell wheel, 120

2880

Circumfer. of roller, 314

11520
2880
8640

9043.20
Spindles in the frame, 120

30240)1085184.00 (35.88
90720

177984
151200

267840
241920

259200
241920

17280

Circumference of the reel, 54 inches
Threads in a lea or skien, 80

4320

Leas or skiens in a hank, 7

30240 inches in one hank.

16 ounces in one pound.

21528
3588

96)574.08(5.98 hank roving required.
480

940
864

768
768

To find the hank roving in fly frames.

RULE. Take two or three bobbins, and reel one lea from each upon a common 54 inch reel, and weigh them; then, as the two or three leas are to their weight, so are

seven leas to the weight of one hank, and having found the weight of one hank, then, as its weight is to one hank, so is one pound to the hank roving required.

EXAMPLE.

Suppose three leas reeled from three separate bobbins weigh 20 drachms; required the weight of one hank?

As 3 leas is to : 7 leas : : so is 20 drs.

$$3 \overline{)140} \quad 20$$

$46\frac{2}{3}$ drs. weight one hank.

Drs. Hk.

As $46\frac{2}{3}$: 1 : : 256 drs. in one pound.

$$\frac{3}{140} \qquad \frac{3}{140)768(5.48}$$

hank roving required.

700

680

560

1200

1120

80

The hank roving in stretching frames may be found by the same process as that given in the above example, and perhaps in practice this method is oftener adopted than any other, being considered fully as correct as any that can be tried.

The hank roving being given—To find what grist pinion will produce any given size of yarn required.

RULE. Divide the size of yarn required by the hank roving given, the result will be the draught or extension the roving must undergo, in order to produce the numbers of yarn required.

EXAMPLE I.

Suppose the hank roving as above, viz. 5.48, what grist pinion will produce No. 60 yarn from the same?

No. of yarn.
Hank roving, 5.48)60.00(10.94 draught required to reduce a 5.48
548 hank roving to No. 60 yarn.

5200
4932

2680
2192

488

No. 60 yarn will require about 6 inches of gaining, which, upon a stretch of 56 inches, is equal to about $\frac{1}{9}$ of the whole, subtract this from the result found above, and multiply the remainder by the number of teeth in the pinion on the front roller of the mule, and the product by the diameter of the back roller: then multiply the teeth in the crown wheel and back roller wheel together,

and their product by the diameter of the front roller. Divide the product of the latter by the product of the former, and the result is the pinion required.

EXAMPLE II.

Draught required as found above, 10.94
Subtract one-ninth equal to 1.21

9.73
Pinion on the front roller, . . 18 teeth

7784
973

17514
Diameter of back roller, . . . $\frac{7}{8}$=7

1225.98

Crown wheel, . . 72 teeth
Back roller do. . . 56

432
360

4032
Dia. of front roller $\frac{8}{8}$=8

1225.98)32256.00(26 grist pinion required to produce
245196 No. 60 yarn on the mule, from
5.48 hank roving.

773640
735588

38052

Note. When the hank roving is given, together with the size of yarn required, all that is necessary, is merely to find the draught the roving must undergo in order to produce the size of yarn wanted. But if we only ascertain the pinion that will produce that draught without taking into consideration the gaining of the carriage, the result obtained will be incorrect. It would also be an easy process to make out tables of the various sizes of yarn produced from any given hank-roving; but even these would be of no utility whatever in practice, as the amount of draught required on the roving must always be regulated by the nature or quality of the cotton used, as that which is short and soft requires much less draught than that which is long and strong; this, however, can only be learned by experience. All that is considered necessary, is to exemplify the principle upon which the preceding calculations proceed, and which may easily be applied to particular circumstances.

To find what grist pinion to put on the mule, so as to change the size of the yarn to any other given size required.

RULE. Multiply the teeth in the present pinion by the size of yarn presently spinning, and divide the product by the size of the yarn required?

EXAMPLE.

If at present spinning No. 60, with a 26 teeth pinion, what pinion must be put on to produce No. 70 from the same roving?

Present size, . No. 60
Present pinion, . 26

Size of yarn required, 70)1560(22 pinion required to produce
140 No. 70.

160
140

20

To find the hank roving from the size of yarn the mules are presently spinning.

RULE. Divide the size of yarn presently spinning by the draught produced by the grist pinion, and multiply the remainder by the length of stretch wanting the gaining. Divide the last product by the full length of the stretch; the result is the hank roving required.

EXAMPLE.

At present spinning No. 60, with a draught of 9.75, and 6 inches of gaining; required the hank roving?

Draught, . . 9.75)60.00(6.15
5850
1500
975
5250
4875
375

Hank roving, . 6.15
Length of stretch wanting gaining, 50

Full length of stretch, 56)307.50(5.49 hank roving required.
280
275
224
510
504
6

To find in what proportion to change the weight of spreading, when changing from one size of yarn to another.

Suppose the present spinning to be No. 80s weft with 38 turns on the fly, and to be changed to No. 90s twist

with 44 turns on the fly, and the present lap 9 oz. on 6 feet; how much must the weight of the lap be reduced, so as to continue the same supply of preparation from the carding engines as formerly?

RULE. Multiply the 80s by the 38 turns, and the product by the weight of the lap, then multiply the 90s by the 44 turns. Divide the product of the former by the product of the latter; the result will be the weight of lap required.

EXAMPLE.

Present size of yarn,	No. 80	Size of yarn required,	No. 90
Present turns,	38	Turns on fly required,	44
	3040		3960

Weight of lap at present, 8 oz.

3960)24320(6 oz. 2 drs., weight of lap required.
23760

560
16 drs. in one oz.

3360
560

8960(2 drs.
7920

1040

The length and weight of the lap being given—To find the size of yarn—The lap to be taken at the finishing carding engines.

RULE. Multiply the length of the given lap by the whole amount of draughts throughout the process, beginning at the finishing carding engines, and divide the product by the whole doublings; the result will be the number of inches produced from the given length of lap: divide this by the inches in one hank, viz. 30240; the last result will be the hanks produced from the given lap. Then as the weight of the given lap (deducting so much for flowings) is to the drachms in one lb, so are the hanks produced from the lap, to the hanks in one pound.

Suppose the weight of the lap, (taken at the finishing carding engine) to be 122 drachms, length of ditto 96 inches, and the draughts as follows:—Draught of carding engine 50, draught of drawing frame, 1st heads, 8.5 × (2d do.) 8.5 × (3d do.) 8.5 = 614.125, draught of fly frame 11½, draught of stretching frame 8, draught of mule 9.14; the number of doublings 2048, allowing 10 drachms for tops, strips, flowings, &c Required the size of the yarn?

EXAMPLE.

Draughts of the drawing frame, 614.125
Do. of carding engines, . . 50
30706.250
Draught of fly frame, . . . 11½
337768750
15353125
353121.875
Draught of stretching frame, . . . 8
2824975.000
Draught of the mule, . . . 9.14
11299900
2824975
25424775
25820271.50
Length of given lap, . . . 96 inches.
15492162900
2323824435
Number of doublings, 2048)2478746064.00 (1210325.22 inches produced from the given lap.
2048
4307
4096
2114
2048
6660
6144
5166
4096
10704
10240
4640
4096
5440
4096

Inches in one hank, 30240)1210325.22(40.02 hanks produced
120960 from the given lap.
72522
60480
12042

The hanks produced as above being 40.02, deduct 10 drachms from the weight of the given lap for tops, strips, flowings, &c.; then as the remainder is to the drachms in one lb., so are the hanks produced from the given lap to the hanks in one pound.

EXAMPLE.

Weight of given lap, 122 drs.
Deduct for flowings, &c. 10

Drs. in a lb. Hks.
112 : 256 : : 40.02
256
24012
20010
8004
112)10245.12(91.47 size of yarn
1008 required.
165
112
531
448
832
784
48

To find the size of the card end at the carding engine, drawing frame, or slubbing frame.

RULE. Measure off any given length in feet; then as its weight multiplied by the number of feet in one hank, so is its length multiplied by the ounces in a pound to the size of the end required.

EXAMPLE.

If $31\frac{1}{2}$ feet of a card end weigh 2 oz.: Required its size?

Oz. feet in a hk. hk. feet. oz. in a lb.

$2 \times 2520 = 5040 : 1 : : 31\frac{1}{2} \times 16 = 504.$

$504 \div 5040 = \frac{1}{10}$, size of card end required.

To find the size after passing through a drawing frame.

RULE. Multiply by the draughts in the drawing frame, and divide by the number of doublings.*

* This is a general rule. Always multiply the given size by the draught it must undergo at the next machine, and divide the product by the doublings (if any;) the result will be the size required, making no allowance for flowings. It should be recollected however, that the end, before it receives twist, will always size finer than afterwards, because the twist takes up a portion of its length, and hence a coarser size.

EXAMPLE.

If the given size be $\frac{1}{10}$ hank, the draughts in the drawing frame 614.125 in all, and the number of doublings 512; required the size after passing the drawing frame?

$$\frac{614.125 \times \frac{1}{10}}{512} = \frac{1}{8} \text{ hank nearly.}$$

Suppose the above end to pass through a slubbing frame with one doubling, and a draught of 14; required the size of the slub?

EXAMPLE.

$$\frac{\frac{1}{8} \times 14}{2} = \frac{7}{8} \text{ size of slub required.}$$

If the $\frac{7}{8}$ hank slub pass through a stretching frame with one doubling and a draught of 8; required the hank roving?

EXAMPLE.

$$\frac{\frac{7}{8} \times 8}{2} \; 3\frac{1}{2} \text{ hank roving required.}$$

Suppose a $3\frac{1}{2}$ hank roving spun in the mule with a draught of 10 and 5 inches of gaining; required the size of the yarn?

RULE. Multiply the hank roving by the draught, and the product by the full length of the stretch. Divide the last product by the length of the stretch wanting the gaining; and the result is the size of the yarn required.

EXAMPLE.

Hk. roving. Draught.

$3\frac{1}{2} \times 10 = 35$

Length of stretch, . . 56 inches.

210
175

Do. wanting gaining, 51)1960(38.43 size of yarn required.
153

430
408

220
204

160

Note. The above yarn would turn out No. 40 in practice in consequence of the flowings.

ON MIXING COTTONS.

Cotton yarn is generally spun from different kinds of cottons mixed together in certain proportions. Every manager has his own method of making up his mixtures, but, perhaps, as good a method as any is to make it up by 100 lbs., containing the proportions of the various qualities; and when the full cost of each proportion in the 100 lbs. is added together, the amount divided by 100 gives the nett price of one pound of the mixture. The following are a few specimens of mixtures for making different qualities of yarn.

For spinning No. 36 pirns.

45 lbs. of Boweds @ 8¼d ℔ lb. = 371¼d.
40 do. Surats @ 7 do. = 280d.
15 do. Waste @ 5½ do. = 82½d.

100 lbs. 100)733¾ = 7⅜d. price of one pound of the mixture.

For spinning No. 40 wefts.

50 lbs. of Boweds @ $8\frac{1}{2}$d. ℔ lb. = 425d.
25 do. Surats @ $7\frac{1}{4}$d. do. = $181\frac{1}{4}$d.
25 do. Waste @ $5\frac{3}{4}$d. do. = $143\frac{3}{4}$d.

100 lbs. 100)750 = $7\frac{1}{2}$d. ℔ lb.

For spinning No. 40 water twist.

50 lbs. of Egyptian @ $12\frac{5}{8}$d. ℔ lb. = $618\frac{5}{4}$d.
20 do. Sea Island @ $15\frac{5}{8}$d. do. = $312\frac{1}{2}$d.
30 do. Stained do. @ $10\frac{3}{4}$ do. = $322\frac{1}{2}$d.

100 lbs. 100)$1253\frac{3}{4}$ = $12\frac{5}{8}$d near.

For spinning No. 50 weft.

50 lbs. of Boweds @ $8\frac{1}{4}$ ℔ lb. = $412\frac{1}{2}$d.
30 do. Orleans @ $9\frac{1}{2}$ do. = 285d.
20 do. Surats @ $6\frac{5}{8}$ do. = $132\frac{1}{2}$d.

100 lbs. 100)830 = $8\frac{3}{10}$d.

For spinning No. 50 twist for power looms.

40 lbs. of Egyptian @ 15d. ℔ lb. = 600d.
15 do. Sea Island @ $17\frac{1}{4}$d. do. = $258\frac{3}{4}$d.
20 do. Stained do. @ $12\frac{3}{4}$d. do. = 255d.
25 do. Pernambucco @ 14d. do. = 350d.

100 lbs. 100)$1463\frac{3}{4}$ = $14\frac{3}{5}$d near.

For spinning No. 60 weft.

80 lbs. of Orleans @ 10½d. ℔ lb. = 840d.
20 do. Demerara @ 11⅜d. do. = 227½d.

100 lbs. 100)1067½ = 10⅔d. nearly.

For spinning No. 64 twist for hand looms.

40 lbs. of Orleans . @ 9¾d. ℔ lb. = 390d.
30 do. Stained Sea Isl. @ 10½d. do. = 315d.
15 do. Pernambucco @ 12⅗d. do. = 189d.
15 do. Demerara . @ 11d. do. = 165d.

100 lbs. 100)1059 = 10⅗d.

For spinning No. 66 twist for power looms.

20 lbs. of Sea Island @ 18d. ℔ lb. = 360d.
40 do. Bahia . @ 14⅝d. do. = 585d.
40 do. Egyptian @ 14⅞d. do. = 590d.

100 lbs. 100)1535 = 15¾d.

For spinning No. 70 weft.

40 lbs. of Orleans . . . @ 8⅞d. ℔ lb. = 350d.
40 do. Bahia . . . @ 10⅝d. do. = 425d.
20 do. Stained Sea Island @ 11¼d. do. = 225d.

100 lbs. 100)1000 = 10d.

For spinning No. 80 weft.

40 lbs. of	Egyptian	@ $14\frac{3}{8}$d. ℔ lb.	=	575d.
20 do.	Orleans	@ $9\frac{5}{4}$d. do.	=	195d.
20 do.	Demerara	@ $10\frac{1}{2}$d. do.	=	210d.
20 do.	Upland	@ $8\frac{1}{4}$d. do.	=	165d.
100 lbs.			100)1145	= $11\frac{1}{2}$d nearly.

For spinning No. 80 twist for hand looms.

30 lbs. of	Sea Island	@ 17d. ℔ lb.	=	510d.
40 do.	Egyptian	@ 15d. do.	=	600d.
30 do.	Demerara	@ 12d. do.	=	360d.
100 lbs.			100)1470	= $14\frac{7}{10}$d.

Note. The above prices annexed to the different cottons are wholly fictitious, being designed only to show the method of keeping the cotton book and finding the prices of the mixtures.

To find the cost of one pound of yarn from the whole produce in any given time, suppose 12 *days.*

RULE. Add together the whole expense of workmanship, and the amount of all incidental charges. Reduce the whole sum to pence, and divide by the pounds produced in 12 days. Reduce the remainder, if any, to 16ths, and divide again by the pounds produced; the result thus obtained will be the cost of one pound in pence and 16ths of a penny.

EXAMPLE I.

Suppose the quantity of yarn produced in 12 days to be 13.736 lbs., equal to 45.440 spyndles, and the expense of workmanship as follows:

In picking room department, . . .	£5	10	6
Carding do.	41	14	8
Spinning and stretching, ...	177	10	4
Ware-room and reeling department, .	37	6	3
Mechanics, ...	8	17	0
Sweeper, porter, and others, ...	1	14	0
Overseers, &c.	2	18	0
Whole expense of workmanship, . .	£275	10	9
Incidental charges for 12 days, suppose	140	0	0
Carried forward, .	£415	10	9

Brought forward, . . . £415 . 10 . 9

20

8310

12

Produced in 12 days 13736 lbs.)99729(7d$\frac{4}{16}$ cost of 1 lb. of yarn.

96152

3577

16ths.

21462

3577

13736)57232(4-16ths.

54944

2288

To find the cost of one pound of yarn, including the price of the raw material.

RULE. Suppose it takes 18½ ounces of cotton to make one pound of yarn, find the price of the 18½ ounces, and add it to the result as found above; this will give the full cost of one pound of yarn including the raw material.

EXAMPLE II.

Suppose the cost of cotton at 10½d. per lb.: then as 16 oz. is to 18½ oz., so is 10½d. to the price of 18½ oz.

oz.		oz.			
16	:	$18\frac{1}{2}$	: :	$10\frac{4}{5}$d.	
2		2		5	
32		37		54	
		54			
		148			
		185			

32)1998(62.43÷5=$12\frac{1}{2}$d. cost of $18\frac{1}{2}$ oz. of cotton;
192 add $7\frac{1}{4}$d. expense of workmanship.
78 $19\frac{3}{4}$d. cost of one lb. of yarn including raw material.
64
140
128
120
96
24

To find the cost of one pound of any number or size in the whole range of spinning.

RULE. Find the number of hanks produced in all, and divide it by the two extremes, or the highest and lowest numbers separately, and divide the whole expense of workmanship by each of the quotients; the results arising from this operation will be the cost of each of these numbers, that is the highest and lowest in the whole range of spinning, which suppose to be No. 80 and No. 40. Having found the cost of the two extremes, subtract the lowest from the highest, and let their difference be equally divided amongst all the intermediate numbers.

EXAMPLE III.

The spyndles produced in 12 days being 45.440, *(See Example I.)* which multiplied by 18, the number of hanks into a spyndle gives the number of hanks in all, thus $45.440 \times 18 = 817.920$ hanks.

No. 4|0)817.92|0

20448 lbs. produced, supposing the whole spinning to have been No. 40.

No. 8|0)81792|0

10224 lbs. produced, supposing the whole spinning to have been No. 80.

Expense of workmanship in pence, 99729d. *(See Example I.)*

Lbs. produced of No. 40, 20448)99729(4$\frac{14}{16}$ Cost of one lb. of No. 40.
81792

17937
16ths.

107622
17937

20448)286992(14-16ths.
20448

82512
81792

720

Lbs. produced of No. 80, 10224)99729(9$\frac{12}{16}$ cost of one lb. of
92016 No. 80.
7713
16-16ths.
46278
7713
10224)123408(12-16ths.
10224
21168
20448
720

From cost of No. 80 = 9$\frac{12}{16}$
Take cost of No. 40 = 4$\frac{14}{16}$

The difference is . 4$\frac{14}{16}$, which being divided by 19, the number of intermediate Nos. gives $\frac{4}{16}$. Therefore let the cost of each intermediate No. advance by $\frac{4}{16}$ths, thus,

Cost of No.	40	42	44	46	48	50
	4$\frac{14}{16}$d.	5$\frac{2}{16}$d.	5$\frac{6}{16}$d.	5$\frac{10}{16}$d.	5$\frac{14}{16}$d.	6$\frac{2}{16}$d.
Cost of No.	52	54	56	58	60	62
	6$\frac{6}{16}$d.	6$\frac{10}{16}$d.	6$\frac{14}{16}$d.	7$\frac{2}{16}$d.	7$\frac{6}{16}$d.	7$\frac{10}{16}$d.
Cost of No.	64	66	68	70	72	74
	7$\frac{14}{16}$d.	8$\frac{2}{16}$d.	8$\frac{6}{16}$d.	8$\frac{10}{16}$d.	8$\frac{14}{16}$d.	9$\frac{2}{16}$d.
Cost of No.	76	78	80			
	9$\frac{6}{16}$d.	9$\frac{10}{16}$d.	9$\frac{14}{16}$d.			

To find the cost of yarn produced from a single system in any given time.

RULE. Find how many feet of carding are in the whole mill by measuring the length of all the finisher doffing cylinders; and again, how many feet of carding are in each system; then find the expense of those departments which are common to all the systems, and take the proportion of that expense according to the proportion which the number of feet in the system bears to the number of feet of carding in the whole mill, and likewise the same proportion of the incidental charges, add them together with the wages paid to the hands employed in the system, and proceed as formerly.

EXAMPLE.

Suppose 120 feet of carding in the whole mill, 30 feet in each system, and 12 pairs of jennies spinning 3168 lbs. of No. 64 warp yarn in 12 days.

Picking room,	3 hands	@ 14/ ₱	12 days,	- - -	£2	2	0
Do.	1	@ 9/	do.	- - - -	0	9	0
Do.	1	@ 18/	do.	- - - -	0	18	0
					£3	9	0

Ft.

Then, as 120 feet of carding : £3 . 9 : : 30 : 17/3 £0 17 3

Brought forward, ...	£0	17	3
One spreader who spreads for 50 feet @ 14/ ℔ 12 days.			
As 50 feet is to : 14/ : : so is 30 feet to : 8/5 .	0	8	5
1 hand @ 4/, and card feeder-breakers 6/ . .	0	10	0
1 do. do. finisher, ...	0	7	0
2 hands, first drawer @ 8/6	0	17	0
2 do. second do. @ 10/	1	0	0
1 hand, slabbing frame, ...	0	9	0
2 toppers @ 14/	1	8	0
1 hand, lapping machine, ...	0	12	0
2 sharpers, one @ 8/ and one @ 14/	1	2	0
Carding master, ...	2	0	0
3 stretchers @ 21/	3	3	0
Spinning 3168 lbs. @ 3¼d.	42	18	0
Reeling @ 1/ for 50 spyndles	11	5	3
Mechanics at £ 12 ℔ 12 days.			
As 120 feet of carding : £12 : : 30 feet of carding : £3.	3	0	0
Overseer @ £ 4 ℔ 12 days.			
As 120 feet of carding : £4 : : 30 feet of carding £1.	1	0	0
Wareroom hands, 3 @ 14/ = £2 2			
Do. 1 @ 12/ = 0 12			
Do. 2 @ 7/ = 0 14			
£3 8			
As 120 ft. of carding : £3 . 8/ : : 30 ft. of carding : 17/	0	17	0
Porter, sweeper, or others, 18/ ℔ 12 days.			
As 120 feet of carding : 18/ : : 30 feet of carding : 4/6	0	4	6
Incidental charges, £ 160 ℔ 12 days.			
As 120 feet : £160 : : 30 feet : £40 . . .	40	0	0
	£111	18	5

The whole proportion of the expense of workmanship belonging to one system is £111 . 18 . 5. Divide this by the pounds produced, and the quotient will be the cost of one pound, to which add the price of the material, and the result will be the nett cost of one lb. of yarn.

£111 . 18 . 5
20
2238
12
26861

Lbs. produced, 3168)26861(8 7/16 d. expense of workmanship for one lb. of yarn.
25344
1517
16-16ths.
9102
1517
24272
3168)24272(7-16ths.
22176
2096

Cost of material, 9½ oz. of Egyptians, @ 14¾d. ℔ lb. = 8 9/16 d.
9¼ oz. Demerara, @ 12d. ℔ lb. = 6 1/16 d.
15 8/16 d.

Expense of workmanship, ℔ lb. . . . . 8 7/16 d.

Nett cost of one lb. of yarn, ... 1/11 1/16 d.

The List Prices by which the wages of operative spinners are regulated.

The cotton spinners of Scotland have been generally paid by the lb., upon a scale rising in price progressively from the lower to the higher numbers of yarn. The price of spinning No. 100 appears to have been uniformly taken as a denomination of the list. Thus the 2/ list is that scale of prices by which cotton yarn of 100 hanks in the pound is paid at two shillings, falling gradually as the numbers descend, and rising as the yarn advances in fineness.

In 1790 or 1791 the 2/ list was drawn up by the cotton spinners in the neighbourhood of Johnston, in the West of Scotland, and in the House of a Mr. William Clark, and continued to be paid in full till the introduction of mechanical power to impel the spinning jenny, which came into pretty general use four years afterwards, when sixpence per shilling was immediately taken off the price paid to the operative spinners for the production and maintenance of the power. Thus for upwards of 40 years the 2/ list has been the standard by which the cotton spinners of Scotland have regulated the wages of their operatives, for all yarns finer than 40 hanks in the pound. During the above period a 2/1d. and a 1/10d. list were introduced, and partially acted upon by a few spinners, both of which, however, have now ceased to exist. *(See Macfarlane's Cotton Spinners' Pay Book.)*

The Two Shilling List, by which the wages of operative spinners are regulated in Scotland.

Nos. of Yarn.	List Price.		Nos. of Yarn.	List Price.		Nos. of Yarn.	List Price.	
	s.	d.		s.	d.		s.	d.
40	0	6	67	1	$0\frac{3}{4}$	94	1	9
41	0	$6\frac{1}{4}$	68	1	1	95	1	$9\frac{1}{2}$
42	0	$6\frac{1}{2}$	69	1	$1\frac{1}{4}$	96	1	10
43	0	$6\frac{3}{4}$	70	1	$1\frac{1}{2}$	97	1	$10\frac{1}{2}$
44	0	7	71	1	$1\frac{3}{4}$	98	1	11
45	0	$7\frac{1}{4}$	72	1	2	99	1	$11\frac{1}{2}$
46	0	$7\frac{1}{2}$	73	1	$2\frac{1}{4}$	100	2	0
47	0	$7\frac{3}{4}$	74	1	$2\frac{1}{2}$	101	2	$0\frac{1}{2}$
48	0	8	75	1	$2\frac{3}{4}$	102	2	1
49	0	$8\frac{1}{4}$	76	1	3	103	2	$1\frac{1}{2}$
50	0	$8\frac{1}{2}$	77	1	$3\frac{1}{4}$	104	2	2
51	0	$8\frac{3}{4}$	78	1	$3\frac{1}{2}$	105	2	$2\frac{1}{2}$
52	0	9	79	1	$3\frac{3}{4}$	106	2	3
53	0	$9\frac{1}{4}$	80	1	4	107	2	$3\frac{1}{2}$
54	0	$9\frac{1}{2}$	81	1	$4\frac{1}{4}$	108	2	4
55	0	$9\frac{3}{4}$	82	1	$4\frac{1}{2}$	109	2	$4\frac{1}{2}$
56	0	10	83	1	$4\frac{3}{4}$	110	2	5
57	0	$10\frac{1}{4}$	84	1	5	111	2	$5\frac{3}{4}$
58	0	$10\frac{1}{2}$	85	1	$5\frac{1}{4}$	112	2	$6\frac{1}{2}$
59	0	$10\frac{3}{4}$	86	1	$5\frac{1}{2}$	113	2	$7\frac{1}{4}$
60	0	11	87	1	$5\frac{3}{4}$	114	2	8
61	0	$11\frac{1}{4}$	88	1	6	115	2	$8\frac{3}{4}$
62	0	$11\frac{1}{2}$	89	1	$6\frac{1}{2}$	116	2	$9\frac{1}{2}$
63	0	$11\frac{3}{4}$	90	1	7	117	2	$10\frac{1}{4}$
64	1	0	91	1	$7\frac{1}{2}$	118	2	11
65	1	$0\frac{1}{4}$	92	1	8	119	2	$11\frac{3}{4}$
66	1	$0\frac{1}{2}$	93	1	$8\frac{1}{2}$	120	3	$0\frac{1}{2}$

Nos. of Yarn.	List Price.		Nos. of Yarn.	List Price.		Nos. of Yarn.	List Price.	
	S.	D.		S.	D.		S.	D.
121	3	1¼	148	5	4	175	7	7
122	3	2	149	5	5	176	7	8
123	3	3	150	5	6	177	7	9
124	3	4	151	5	7	178	7	10
125	3	5	152	5	8	179	7	11
126	3	6	153	5	9	180	8	0
127	3	7	154	5	10	181	8	1
128	3	8	155	5	11	182	8	2
129	3	9	156	6	0	183	8	3
130	3	10	157	6	1	184	8	4
131	3	11	158	6	2	185	8	5
132	4	0	159	6	3	186	8	6
133	4	1	160	6	4	187	8	7
134	4	2	161	6	5	188	8	8
135	4	3	162	6	6	189	8	9
136	4	4	163	6	7	190	8	10
137	4	5	164	6	8	191	8	11½
138	4	6	165	6	9	192	9	1
139	4	7	166	6	10	193	9	2½
140	4	8	167	6	11	194	9	4
141	4	9	168	7	0	195	9	5½
142	4	10	169	7	1	196	9	7
143	4	11	170	7	2	197	9	8½
144	5	0	171	7	3	198	9	10
145	5	1	172	7	4	199	9	11½
146	5	2	173	7	5	200	10	1
147	5	3	174	7	6			

The above List rises ¼d. every No. from No. 40 to No. 88, from that to No. 110, it rises ½d.; from No. 110 to No. 122, it rises ¾d.; from No. 122 to No. 190, it rises 1d.; and from that upwards, 1½d. each number.

The operative spinners in Glasgow and neighbourhood, receive 3¼d. out of each shilling, when their wages are calculated by the foregoing List; but throughout the whole of Renfrewshire, the proprietors, in consequence of their distance from the market, pay 3d. out of the shilling, with an allowance of six additional sizes for pirn copes under No. 54; four sizes for all above that No., and three sizes for power loom warps.

In Glasgow operative spinners are paid 3/6½d. per 1000 hanks for all Nos. under No. 40. In Renfrewshire, at present, there is no regular standard for Nos. below No. 40: the two shilling list is in some Factories brought down as low as No. 30, that is, falling one farthing for every size from 40^s to 30^s. The only other standard for Renfrewshire to which the writer has had access is the following: For all Nos. from No. 10 to No. 24, the operatives receive one penny for every 22 hanks; and pirn copes from No. 16 to No. 20, are paid 7/4 per 100 lbs.: From No. 20 to No. 26, 1¼d. per lb.

The following Table is constructed decimally, according to the standard paid in Glasgow for all Nos. below No. 40; viz. 3/6½d. ℔ 1000 hanks.

NOS.	D.	NOS.	D.	NOS.	D.	NOS.	D.
1	.425	11	.4675	21	.8925	31	1.3175
2	.085	12	.51	22	.935	32	1.36
3	.1275	13	.5525	23	.9775	33	1.4025
4	.17	14	.595	24	1.02	34	1.445
5	.2125	15	.6375	25	1.0625	35	1.4875
6	.255	16	.68	26	1.105	36	1.53
7	.2975	17	.7225	27	1.1475	37	1.5725
8	.34	18	.765	28	1.19	38	1.615
9	.3825	19	.8075	29	1.2325	39	1.6575
10	.425	20	.85	30	1.275		

To find the operatives pay by the above Table.

Suppose 650 lbs. of No. 38; the value of one lb. being 1.615d. multiply it by 650; the product is the pay in pence.

1.615
650
80750
9690
12|1049.750
20|87 . 5¾
4 . 7 . 5¾

The following is the standard Pirn List, by which operative spinners are paid in Glasgow for all Nos. below No. 40.

Nos.	Price per 1000 hanks.		Price per lb.	Nos.	Price per 1000 hanks.		Price per lb.
	S.	D.			S.	D.	
10	5	2	.62	25	4	6½	1.3525
11	5	1½	.6765	26	4	6	1.404
12	5	1	.732	27	4	5¾	1.45125
13	5	0½	.7865	28	4	5½	1.498
14	5	0	.84	29	4	5¼	1.54425
15	4	11½	.8925	30	4	5	1.59
16	4	11	.944	31	4	4¾	1.63525
17	4	10½	.9945	32	4	4½	1.68
18	4	10	1.044	33	4	4¼	1.72425
19	4	9½	1.0925	34	4	4	1.768
20	4	9	1.14	35	4	3¾	1.81125
21	4	8½	1.1865	36	4	3½	1.854
22	4	8	1.232	37	4	3¼	1.89
23	4	7½	1.2765	38	4	3	1.92
24	4	7	1.32	39	4	2¾	1.96

It has already been stated, that the two shilling list is the standard by which the cotton spinners of Scotland have regulated the wages of their operatives for upwards of forty years. The operatives in Glasgow and neighbourhood, when paid by this list, receive 8¼d. out of each shilling.

The following Table has been constructed decimally, according to the above rate of payment, viz. $3\frac{1}{2}$d. out of the shilling, and shows the nett price per lb. in pence and decimal parts of a penny. It is also adapted for various kinds of work, viz. weft copes, pirn copes, power loom warps, and large copes with paper slips. For example, if No. 50 be the No. spinning, the operative is paid at the rate of 52^s for large copes with paper slips; at the rate of 53^s for power loom warps; and at the rate of 56^s for pirn copes, &c.

NOS.	D.	NOS.	D.	NOS.	D.	NOS.	D.
40	1.625	58	2.844	76	4.062	94	5.687
41	1.692	59	2.911	77	4.13	95	5.823
42	1.76	60	2.979	78	4.198	96	5.959
43	1.828	61	3.047	79	4.266	97	6.094
44	1.896	62	3.115	80	4.333	98	6.229
45	1.963	63	3.182	81	4.401	99	6.364
46	2.031	64	3.25	82	4.469	100	6.5
47	2.099	65	3.318	83	4.537	101	6.635
48	2.167	66	3.385	84	4.604	102	6.771
49	2.234	67	3.453	85	4.672	103	6.907
50	2.302	68	3.521	86	4.74	104	7.042
51	2.37	69	3.588	87	4.807	105	7.177
52	2.437	70	3.656	88	4.875	106	7.312
53	2.505	71	3.724	89	5.010	107	7.448
54	2.573	72	3.792	90	5.146	108	7.583
55	2.641	73	3.86	91	5.282	109	7.719
56	2.708	74	3.927	92	5.417	110	7.855
57	2.776	75	3.995	93	5.552	111	8.057

TABLE CONTINUED.

NOS.	D.	NOS.	D.	NOS.	D.	NOS.	D.
112	8.26	122	10.291	132	13.	142	15.708
113	8.463	123	10.562	133	13.272	143	15.979
114	8.666	124	10.833	134	13.543	144	16.25
115	8.869	125	11.104	135	13.812	145	16.521
116	9.072	126	11.375	136	14.084	146	16.792
117	9.275	127	11.646	137	14.354	147	17.063
118	9.478	128	11.917	138	14.625	148	17.333
119	9.681	129	12.188	139	14.897	149	17.604
120	9.884	130	12.459	140	15.168	150	17.874
121	10.087	131	12.73	141	15.438		

ERRATA.

Page 35, line 1. For *doffing cylinder*, read *main cylinder*.
..... 2. For *main cylinder*, read *doffing cylinder*.

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